flagro **TECHNICAL RESOURCE:**

HEATING
PROPANE/LP GAS | VAPORIZERS

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Industrial Heater Fuel Source Options

For proper heater operation, the correct fuel supply configuration must be made for the fuel that is used. Typically, industrial heaters are able to utilize one of three (3) fuel supply options: propane, natural gas, or fuel oil. Of the three, the use of propane requires the most attention and planning. Natural gas is plumbed into a facility from underground, and as long as the supply pressure is at least 2 PSI, the heater will be able to make heat. Fuel oil is stored in a tank, delivered in liquid from from a truck, and is efficient regardless of ambient temperature. Propane is a more efficient heat source than natural gas, but its use is dependent on outdoor ambient temperature and the size of the storage tank. **This document discusses how to configure and install a propane fuel supply system that will meet your heating needs.**

The most common way of using propane as a fuel source makes use of natural vaporization. In this method, ambient air around the tank warms the liquid propane inside causing it to boil off vapor propane, which is pulled for use from the top of the tank. This is what fuels your barbeque grille as well as the propane torch that you use to start a bonfire. Note that the fuel draw that these devices require is substantially less than that required by an industrial heater at high fire. In order to fuel an industrial heater, even a small one, at full capacity for longer than an hour or two, will require multiple 100# tanks; a larger heater will require far more vapor propane capacity than 100# tanks can supply.

Propane is stored in the tank as a liquid under pressure and ambient air around the tank (typically above the -44°F liquid/vapor threshold of propane) is absorbed through the surface of the tank to change the state of the propane inside from liquid to vapor. A full tank (which is only 80% full) has the maximum “wetted” surface area, exposes the liquid propane to the greatest tank surface area. The greatest wetted surface exposes the propane liquid to the most ambient temperature heat, which in turn produces the most propane vapor within the tank. With each larger sized tank, substantially more wetted surface is available to aid in natural vaporization.

A boiling point of -44°F may seem well outside the range of usual ambient temperatures, but as the mercury drops the rate of natural vaporization drops as well. As the outside air temperature gets colder, the liquid propane in the tank shrinks in volume, creating a loss of vapor pressure. This

drop in pressure can lead to an insufficient propane vapor supply which reduces the effectiveness of the heater. In addition, cold weather combined with a low level of propane in the tank leads to a low liquid to tank surface ratio where the liquid propane in the tank is not exposed to enough tank surface area to overcome the cold temperature of the ambient air and vaporization occurs very slowly, if at all. This is why a barbeque grille may not be able to reach full flame in the winter. In extreme cases, the outside of the propane tank can freeze over. The frost on the outside of the tank surface also serves as an insulator that further reduces the available ambient heat to aid in vaporization inside the tank.

Vapor Propane Supplied by a Vaporizer

If sufficient propane vapor supply is not available with an existing propane tank configuration, and adding tanks is either unfeasible or not cost effective, a propane vaporizer will need to be procured and configured for the installation. (Some jurisdictions also limit or restrict that number of propane tanks that can be employed at a site.) Larger commercial heaters often require more propane vapor than tanks alone can supply naturally and a vaporizer must be employed.

A vaporizer is a stand-alone device that heats liquid propane to the point at which it becomes propane vapor. The heat is in the form of an open flame which warms the surface of a heat exchanger (liquid reservoir) that contains liquid propane. The propane vapor that is boiled off rises to the top of the heat exchanger and is funnelled through a valve and into the line that runs to the heater (or propane consuming device). A vaporizer can supply a constant volume of propane vapor to the unit, even at lower temperatures, and is able to process nearly 100% of the liquid propane in the tank.

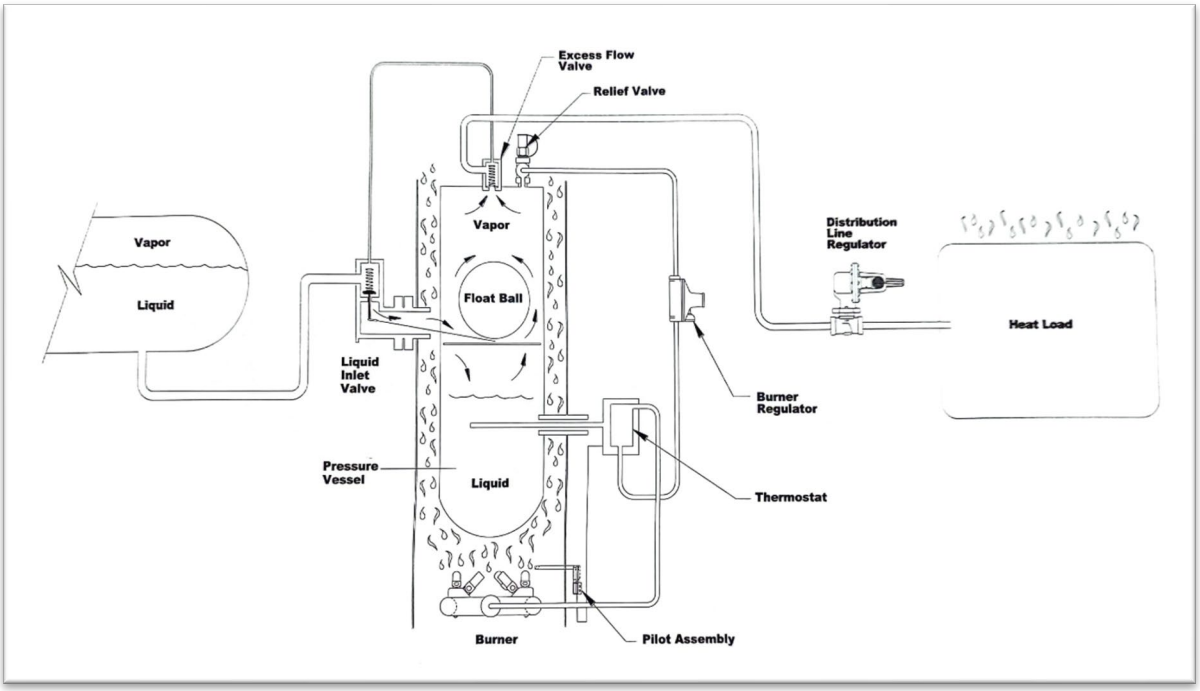

Figure 1: Algas-SDI Direct Fired Vaporizer Manual PN 52642, pg. 1-1

Determining Heater Propane Requirements

The Rating Plate on each industrial heater details the minimum fuel requirements necessary to run the heater at peak performance. The BTU/HR INPUT field list the maximum heating capacity of the heater. In the case of the DFV400RC shown to the right, the INPUT BTU/HR is 390,000. In order to run the heater, a minimum of 8.0 in. W.C. of propane will be required at the GAS INLET, but to reach the MAXIMUM BTU/HR INPUT number of 390,000, the MAXIMUM INLET PRESSURE of 13.0 in. W.C. will be required.

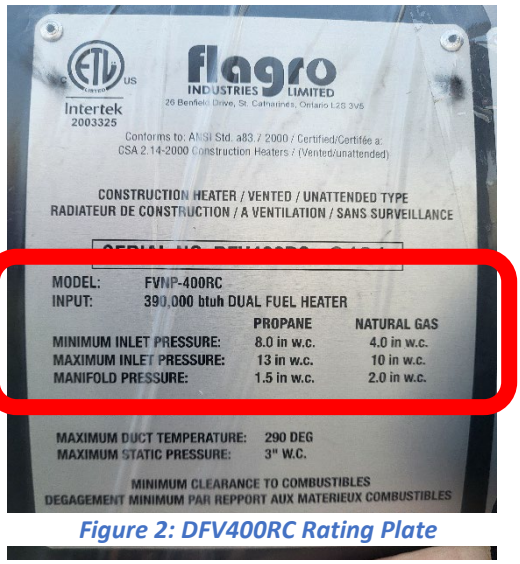

Figure 2: DFV400RC Rating Plate

Determining Adequate Propane Capacity (< 300,000 BTU/HR units)

Sizing propane tank usage for industrial heaters can be confusing, and propane capacity is subject to ambient temperature and how full the tank is. The accepted standard is that one 100-LB. tank is required for one 75,000 BTU/HR heater, two 100# tanks manifolded together for one 150,000 BTU/HR heater, and three 100# tanks for one 225,000 BTU/HR heater. As is shown in Figure 3 below, operating a 300,000 BTU/HR heater with two 100# tanks, even if they are full and the temperature is at least 20°F, is possible but once the tanks drop below 80% full, high fire will not be sustainable. With a 300,000 BTU/HR heater, manifolding three or four 100# tanks together would provide a better heating solution. Any tank smaller than 100# is not practical for an industrial heater rated above 300,000 BTU/HR. A full 20# propane tank, commonly used with barbeque grills, only provides 45,000 BTU/HR capacity when the temperature is at 20°F.

Lbs. of Propane in Cylinder	0-degree F 1 tank	20-degree F 1 tank	0-degree F 2 tanks	20-degree F 2 tanks	0-degree F 3 tanks	20-degree F 3 tanks
100	113,000	167,000	248,000	367,000	545,000	807,000
90	104,000	152,000	228,000	334,000	501,000	734,000
80	94,000	137,000	206,000	301,000	400,000	662,000
70	83,000	122,000	182,000	268,000	363,000	589,000
60	75,000	109,000	165,000	239,000	310,000	453,000
50	64,000	94,000	141,000	206,000	260,000	382,000
40	55,000	79,000	121,000	174,000	217,000	319,000
30	45,000	66,000	99,000	145,000	217,000	319,000
20	36,000	51,000	79,000	112,000	174,000	246,000
10	28,000	38,000	62,000	84,000	136,000	184,000

Figure 3: Liquid Propane Vaporization Rates, 100 Pound Tanks

Determining Adequate Propane Capacity (> 300,000 BTU/HR units)

In order to establish the minimum tank size and the number of tanks needed to meet a certain MAXIMUM BTU/HR INPUT capacity with natural vaporization on larger heater units, Propane Vaporization Rate Charts are employed. For any heater with a capacity greater than 300,000 BTU/HR, 500- or 1000-gallon tanks will be the minimum that will allow the units to reach and maintain high fire. The charts below show the vaporization rate for 500- and 1000-gallon tanks, which are necessary to select properly sized propane storage tank(s). As mentioned above, the crucial factors in the natural vaporization process are the ambient air temperature around the tank and the liquid propane volume in the tank.

Both the 500-gallon and 1000-gallon Vaporization Rate charts are used in the same way. The left column indicates the ambient air temperature present around the tank and the row at the top indicates how much propane liquid is in the tank. Simply reference the ambient temperature on the left and how much propane is in the tank on the top and the intersecting number in the table will indicate the BTU/HR withdrawl is available from a single 500-gallon tank. The BTU/HR figures in the tables are approximate.

Outside Air Temperature in °F/°C	Percentage of Fuel in 500 Gallon Tank							
	10%	20%	30%	40%	50%	60%	70%	80%
90/32	523,250	659,750	864,500	1,001,000	1,162,500	1,296,750	1,456,000	1,638,000
80/27	465,920	614,250	773,500	910,000	1,055,600	1,183,000	1,351,350	1,487,850
70/21	418,600	559,650	682,500	819,000	966,500	1,087,350	1,214,850	1,351,350
60/16	374,920	486,850	605,150	728,000	841,750	910,000	1,078,350	1,192,100
50/10	327,600	432,250	532,350	637,000	737,100	841,750	941,850	1,023,750
40/4	273,000	364,000	455,000	546,000	637,000	728,000	805,350	841,750
30/-1	227,500	304,850	373,100	455,000	523,250	609,700	682,500	750,750
20/-10	182,000	236,600	304,850	364,000	395,850	447,750	532,350	614,250
10/-12	135,500	182,000	227,500	273,000	295,750	364,000	386,750	455,000
0/-18	91,000	113,750	154,700	182,000	204,750	236,000	259,350	295,750
-10/-23	45,000	59,150	77,350	91,000	100,100	113,750	136,500	150,150
-20/-27	22,750	29,125	38,250	45,150	50,000	56,250	68,200	75,100

Figures Represent BTU/hr Withdrawal

Figure 4: Liquid Propane Vaporization Rates, 500 Gallon Tank

Outside Air Temperature in °F/°C	Percentage of Fuel in 1000 Gallon Tank							
	10%	20%	30%	40%	50%	60%	70%	80%
90/32	1,055,600	1,342,250	1,615,250	1,911,000	2,184,000	2,457,000	2,730,000	3,003,000
80/27	964,600	1,219,400	1,487,750	1,729,000	1,979,250	2,238,600	2,502,500	2,730,000
70/21	684,500	1,092,000	1,319,500	1,547,000	1,774,500	2,002,000	2,229,500	2,457,000
60/16	773,500	978,250	1,183,000	1,525,000	1,592,500	1,797,250	2,002,000	2,206,750
50/10	682,500	855,400	1,023,750	1,325,000	1,378,750	1,569,750	1,751,750	1,933,750
40/4	582,400	728,000	887,250	1,150,000	1,183,000	1,342,250	1,501,500	1,660,750
30/-1	491,400	523,250	728,000	864,500	1,001,000	1,128,400	1,251,250	1,387,750
20/-10	391,300	477,350	491,500	682,500	796,250	896,350	1,000,100	1,092,000
10/-12	291,200	364,000	432,250	523,250	591,500	673,400	750,750	819,000
0/-18	200,200	236,600	295,750	341,250	395,850	455,000	500,500	546,000
-10/-23	109,200	127,400	145,600	182,000	204,750	227,500	250,250	273,000
-20/-27	50,000	64,200	720,350	90,250	101,300	112,250	122,150	135,250

Figures Represent BTU/hr Withdrawal

Figure 5: Liquid Propane Vaporization Rates, 1000 Gallon Tank

NOTE: These three Vaporization Rate tables (Figures 3-5) can also be used when diagnosing a troublesome installation. All propane-consuming appliances must receive the required volume flow of gas at the proper pressure for full performance. Adequate propane-storage capacity must be maintained to assure sufficient natural vaporization and prevent the heater from locking out on a flame failure. Cold climates and severe weather conditions may lead to fuel vapor recondensing hazards, which will also reduce the supply of natural propane vapor available to the heater. Other factors that affect the vaporization rate of liquid propane include tank location, wind velocity, humidity, altitude, and type of demand, such as periodic or continuous draw.

Examples of Propane Tank Sizing

Example 1: Assume that you have a full 500-gallon propane tank and the outside ambient temperature is 40°F (4°C). At this 40°F (4°C) temperature, Figure 4 above shows that a full 500-gallon tank can only provide 841,750 BTU/HR. continuous draw. When the tank level falls to 50% full, the withdrawable amount drops to 637,000 BTU/HR. If the ambient temperature falls to 20°F (-10°C) a 50% full 500-gallon tank can only provide 395,850 BTU/HR. continuous withdraw rate. To get full performance from the heater, the volume of available BTUs of propane must be enough to fuel the heater for its rated capacity.

Example 2: For continuous withdraw where temperatures may drop to 0° F (-18° C), assume the vaporization rate of an 80% full 1000-gallon tank is approximately 546,000 BTU/HR. To calculate the number of tanks required to fuel a 4,500,000 BTU/HR heater at capacity, divide the total load in BTU/HR (4,500,000 BTU) by the BTU/HR withdraw rate (546,000).

Example:

$$\frac{\text{4,500,000 BTU REQUIRED}}{\text{546,000 BTU WITHDRAWL}} = \text{Number of tanks required (rounded up to whole integer)}$$

Calculation:

$$\frac{4{,}500{,}000 \text{ BTU REQUIRED}}{546{,}000 \text{ BTU WITHDRAWL}} = \text{Nine (9) 1000-gallon tanks required}$$

IMPORTANT: If propane tank sizing is not feasible with a natural vaporization setup, a propane vaporizer will need to be installed and configured for the installation.

Propane Tank Installation

When installing propane tanks, the location must keep the tanks away from potential damage or contact with machinery and away from traffic and walkways. All tanks must be mounted on a firm base and secured to a permanent or stationary structure. Make sure that propane tank installation adheres to the storage guidelines in Figure 6. The vapor-supply fuel line from the tank must have a first-stage regulator located at the tank to reduce the tank pressure to the 10-PSI needed to supply the unit. Leak test all gas connections using a 1:3 solution of soap and water.

Propane tanks MUST BE KEPT UPRIGHT. If a tank has fallen or been tipped on its side, wait an hour to allow the contents of the tank to settle after standing them up. There is a propane oil residue in the tanks and if that debris gets in the valve, you can run into issues.

Storage Capacity Above Ground	Minimum Distance from Building
One, 500-gallon tank	10 feet
One or two, 1000-gallon tank	25 feet
2001-gallon or more	50 feet

Figure 6: Propane Tank Storage Guidelines

IMPORTANT: Installation must comply with all state and local codes or, in the absence of local codes, with the standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

Propane Vaporizer Installation

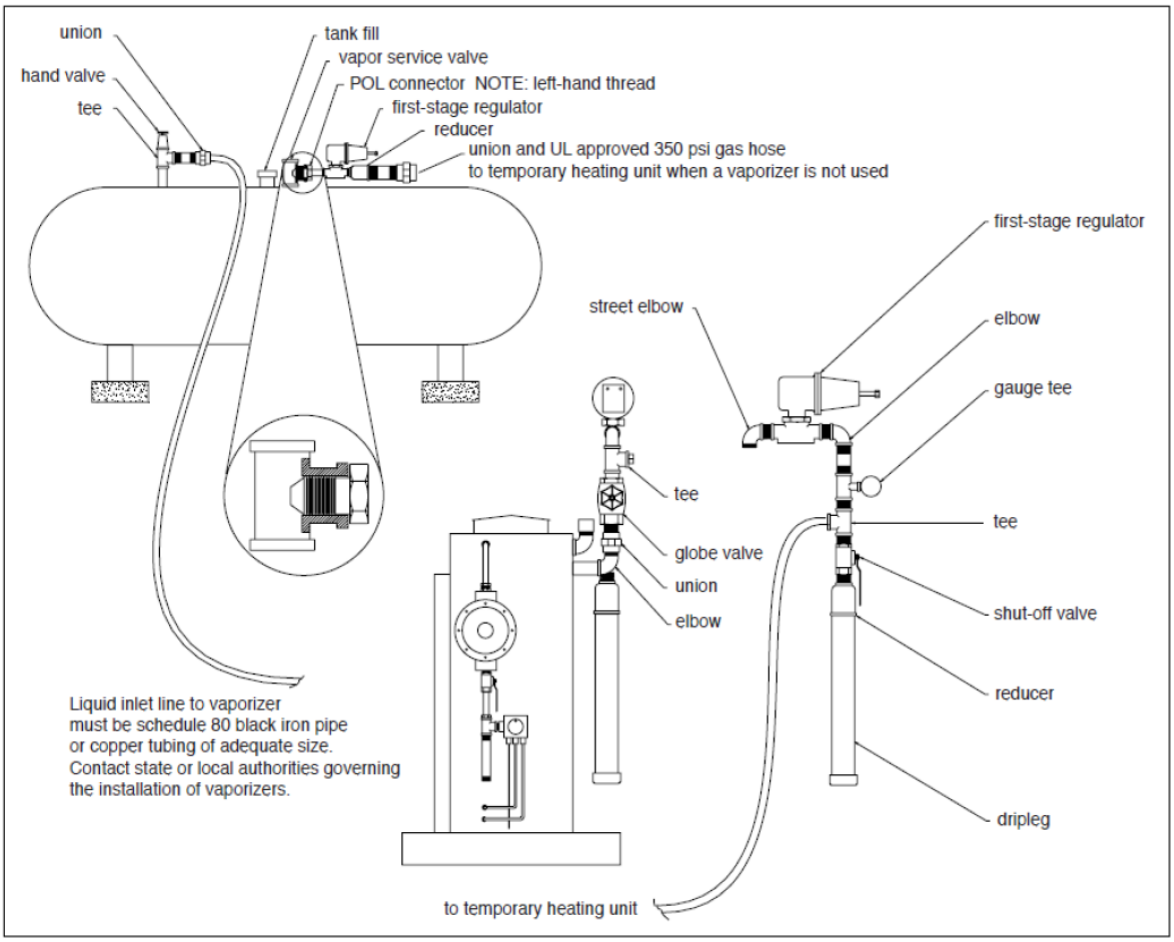

Figure 7: Typical Propane Vaporizer Installation

The vapor-supply fuel line from the vaporizer must have a first-stage regulator located at vaporizer to reduce the tank pressure to the 10-PSI needed to supply the unit. It is vital with a vaporizer to use the proper regulator and connect it to the heater with the correct connection piping size. The vaporizer must be run at the correct pressure range and the bypass vent must be uninhibited. Leak test all gas connections using a 1:3 solution of soap and water.

Placement of a vaporizer must meet the following conditions:

- No closer than 10-ft. from a propane storage container.
- At a minimum 15-ft. from fuel transfer valves.
- Liquid line connection must be Schedule 80 black pipe or copper and of sufficient size.
- Keep combustibles at least 2O feet from the vaporizer.

IMPORTANT: Installation must comply with all state and local codes or, in the absence of local codes, with the standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58.

Flagro is a quality manufacturer of portable heaters, liquid and vapour propane torches, and liquid burners. Our manufacturing facility is based in St. Catharines, Ontario, Canada and has been producing high quality heaters for decades. Our line of heating products contains a wide variety of oil, propane, and natural gas fired commercial portable direct and indirect heaters that range in BTU from 85,000 BTU/hr to 1,500,000 BTU/hr.

Flagro, established in 1978, has been able to expand our manufacturing facility and add additional products to our lineup. Recently we have expanded our product offerings to include the Airrex product line of portable air conditioners, heat pumps, dehumidifiers, and air scrubbers/HEPA filtration units. Our goal is to become your one-stop shop for all your portable HVAC needs.

We pride ourselves on the quality of our products along with an unmatched dedication to customer service and technical support. Each of our Flagro and Airrex products is tested by qualified technicians to ensure that they meet all applicable regulatory and safety standards.

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